Influence of Habitat Types on Prairie Nesting Waterfowl Nest Density and Nest Success in Northeastern North Dakota, 2010 – 2013

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Abstract: Waterfowl representing 8 species of prairie nesting ducks were systematically surveyed from late-April thru late August, 2010 - 2013 to compare nest density, nest success and vegetative structure used by nesting ducks in either native restoration sites or non-native planted vegetation commonly known as dense nesting cover (DNC). We located 4,286 waterfowl nests over 4 breeding seasons. Nest densities in native restored uplands averaged 1.13 ($\pm$ .48) nests per acre compared with 1.41 ($\pm$ .12) for DNC. These results indicated that sampled nest densities were not equal (.25 < P < .50) within these 2 cover types. Nest densities for 5 species of prairie nesting puddle ducks showed that they did not nest evenly across both habitat types examined (.10 <P < .25). Average Mayfield nest success equaled 38% ($\pm$ 18%) for natives compared to 48% ($\pm$ 10%) for DNC; Mayfield results in either cover type over the 4 year study period is well above the minimal nest success of 15% needed to maintain prairie nesting waterfowl across northeast North Dakota. However, late season nest success in 2011 was lower than 15% in native restored uplands suggesting that perhaps predators, nest cover, prior year's management, field location or all combined factors may contribute to explain the poor performance during that particular year. Nest success results for 2010, 2012 and 2013 indicated a more normalized and consistent nest success result within native vegetation; nest success remained very consistent in DNC sites throughout the 4 years of investigations. Finally, habitat structure at waterfowl nest sites differed, vegetation height and visual obstruction were significantly lower (.10 >p > .05) in Native habitat versus DNC, litter depth was not significantly different in either field type. Performance within either native or non-native cover type indicated that both restoration techniques used to restore upland habitats works well for prairie nesting ducks, but DNC has higher productivity both from a nest density and nest success perspective, especially for mallard and gadwall. However, plant species richness typified by native restoration sites may provide a more resilient habitat type especially in the face of more frequent climatic oscillations, and may provide more niches and more habitat structural diversity for a greater diversity of wildlife species. Published data suggests that non-native grassland restorations lack resilience in the face of severe drought, and may be prone to accelerated invasion by noxious weeds and other non-native invasive species. Also, Native upland restoration techniques may play a more pivotal role towards diversifying prairie landscapes in the long term as DNC is a much shorter lived habitat type. Native habitat restoration methods have proven to be adequate for producing adequate nest cover for prairie nesting ducks. A more diversified and resilient landscape is argued by climate scientists as one critical activity needed to retard impending climate change, this study provides a baseline effort showing that localized waterfowl production objectives can be achieved with native vegetation while potentially addressing a larger ecological question.

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completion, and interest in this waterfowl/habitat question. Also, Cami Dixon and Roger Hollevoet, Dustin VanThuyne, Brandon Hanson, J. Clint Perkins, Kyle Johnson and Sara Pederson of the U.S. Fish and Wildlife Service, Tom Buhl of U.S. Geological Survey-Northern Prairie Wildlife Research Center for his efforts is securing funding and collecting and analyzing the critical field data to make this project a success.

Introduction

The Prairie Pothole Region (PPR), located in the north-central United States and Canada, serves as the primary breeding grounds for the majority (50-80%) of North America's waterfowl species (Bellrose 1980, Batt et al. 1989). Historically dominated by mixed and tall-grass prairies (Johnson et al. 2008) and named for its extensive range of uplands with wetlands interspersed within the landscape, the PPR provides excellent loafing, roosting, and nesting sites for the reproduction of waterfowl (Kantrud and Stewart 1977). The region has become a large area of concern in recent years as 47% of palustrine wetlands have been lost in North Dakota, 35% in South Dakota, and >95-99%% in Minnesota Iowa (Dahl 1990). Also alarming is the fact that ≥ 70% of the native grasslands in the region have been converted to other uses, with 60% being converted to agriculture (USDA 2000). Each year, more native prairie is disked up and converted into agriculture. The PPR is the most intensively managed landscape in North America despite its low population (Johnson et al. 1994).

Restoration of a fragmented landscape is difficult and time consuming considering the planning, monitory demands, actual restoration implementation, post-restoration management and habitat monitoring that is required to succeed in this venture. These activities in most cases take years to achieve. Broader yet is the adaptive management that co-occurs with these restoration activities, often times it is sagacious to conduct a restoration effort, evaluate the outcomes, them make adjustments to continuously improve the techniques. Restoring native vegetation to the upland prairie landscape is not a new concept, but putting this technique into practice and evaluating its direct effectiveness for the benefit of prairie nesting waterfowl is new. Past restoration activities focused on non-native cool season grasses and forbs which were cheap, easy to establish, and provided a superior nesting cover for prairie ducks. Given the fact that during the 1950's – 1980's, the lack of nesting cover was alarming, plantings of upland grasses and forbs was seen as a major benefit for ducks and other wildlife species relying on some resemblance of prairie habitat structure. Over time however, problems began to exist with restoration efforts reliant upon non-native vegetation, and efforts were made to improve restoration techniques using native vegetation. A list of advantages (and disadvantages) to that end appeared, and since 1994 within the Devils Lake WMD, a mix of both dense nesting cover(DNC) and native vegetation (Native) restoration efforts have been practiced; both techniques have achieved abundant success and failures. What was not known is the effectiveness of native upland mixes and how they pertain to prairie nesting ducks.

Today, many stands of both DNC and Natives exist and biologist sought to monitor the effectiveness of both cover types with one simple question; is Native vegetation better, worse or about equal to DNC with respect to waterfowl productivity. Four basic objectives for this study were created;

A. Evaluate and compare nest density and nest success of waterfowl in fields of DNC and Native restoration habitat types where nest density is at least 1 nest per 5 acres of habitat, and nest success is greater than 15%.
B. Assess landscape variables that may impact waterfowl use of restored sites to assist DLWMD staff in prioritizing sites for restoration.

C. Assess the vegetative components of each study field by collecting vegetative structure data at both waterfowl nests and at random locations for the purpose of detecting patterns of nest site selection if they exist.
D. Monitor all species of nesting waterfowl separately and track the phenology and nest site characteristics of each species throughout the nesting season to potentially detect patterns of nest site selection of each species of prairie nesting ducks.

Funding Activities

Funding for this study was made possible by multiple partners. Collectively, this project totaled \$71,040.00 in SWG and non-federal matching dollars. All non-federal matching funds were provided by Southern Illinois University (SIU) and equaled \$35,520.00. State Wildlife Grant awards totaling \$14,850.00 was awarded to SIU, and fully spent. The remaining \$20,607.00 SWG dollars were issued to the USFWS – Devils Lake Wetland Management District and fully spent by November, 2013.

Study Areas

We investigated numerous Waterfowl Production Areas (WPA) and 1 National Wildlife Refuge (Lake Alice NWR) for nesting ducks located within the Devils Lake Wetland Management District in northeastern North Dakota which encompassed 10,146 mi^2 (Figure 1). We monitored nesting ducks in 14 fields and the total area searched was approximately 1,235 acres in size (Figure 2) with the average size of field searched averaging 88 acres ($\pm$ 40ac.). Native upland habitat comprised 5 fields equaling 446 acres searched and 9 DNC fields totaling 779 acres. All sites selected we squarely located within the mixed-grass prairie portion within the District, and had numerous wetland densities associated within and adjacent to each site. Palustrine temporary, seasonal and semi-permanent wetland densities were very similar at each study site regardless of cover type. Throughout the 4 years of investigation, precipitation levels exhibited average to above average conditions while wetland conditions as measured by percent full were in very good (>75% - 100%) to excellent (>100%) condition.

Management of each field (past and present) was perhaps the most “uncontrollable” variable within the study, and this factor could not be quantified nor should not be overlooked. The reader is warned that some results, good or bad, may be a factor of active management, but generally enough habitat had undergone a period of idleness (3 – 5 years from management) which allowed us to use waterfowl nest results in a meaningful way, and make predictions and model the effectiveness of Native and DNC nest cover and nest success.

Native Vegetation Defined

Experimentation with native seeding that took place 20 years ago in the Drift Prairie and Red River Valley areas of North Dakota usually included a limited mixture of 3-5 native warm-season grasses. Fields restored using Native vegetation within the past 10 years consisted primarily of over 20 species of cool and warm season grasses and forbs, arriving at roughly 50-75% grasses, and 50-25% forbs and small shrubs (Figure 4). We searched for nesting ducks within 5 fields restored with multi-species native mixtures; Native study field sizes averaged 89.2 acres ($\pm$ 37 ac) with the average age of the stand near 8 years. Please see Figure 3 for a typical sample of plants used and a planning sheet used in the actual Native upland restoration.

Dense Nesting Cover Defined

Traditionally, areas within the DLWMD and other WMD’s throughout the PPR were re-seeded to herbaceous mixtures that typically included 4 plant species such as cool-season introduced grasses and legumes (intermediate wheatgrass [Agropyron intermedium], tall wheatgrass [Agropyron elongatum], and alfalfa [Medicago sativa] and/or sweetclover [Melilotus officinalis]). These mixture, referred to as dense nesting cover (DNC) were utilized from the early 1980's and continue today in a more limited capacity, typically on sites that contain higher than average salinity (Figure 4). This seed mixture has been touted by many waterfowl biologists as a premium waterfowl nesting cover due to its robustness (i.e. high vegetation height and visual obstruction scores). We searched for nesting ducks within 9 fields restored with DNC and the average DNC field size investigated was 87 acres (± 47 ac) with the average stand age of 9 years.

Methods

Nest Density and Nest Success

We located upland nesting ducks using a modified cable chain dragged behind 2 all-terrain vehicles (Higgins et al. 1977) beginning in the last week of April until all nest detections ceased, typically by the middle-end of July. Each field was searched every 10 days to maximize new detections of nesting attempts and to obtain a measurement of nest density and also to detect nesting phenology of prairie ducks. Nests were simply tallied up and we took the number of nests found and divided by the total acreage which produced an output estimate of nests per acre. We marked each nest with a wooden stake 10 m north of the nest and placed a small orange metal rod directly next to the nest to assist in later detection of nest location. Data collected at the nest were recorded on USGS Habitat/Nest Record Cards; species of hen, number of eggs, incubation, and GPS coordinates, date detected etc. (Appendix 1). We determined the age of the nest by using a simple field candler as described by Weller (1956). Nests were revisited every 7-8 days until the fate of the nest was determined, and data recorded during those visits included date of visit, number of eggs present, incubation stage, description of depredation. Nests were considered successful if ≥1 eggs hatched. If nests failed, a USGS Nest Depredation Form (Appendix 2) was completed for analysis of not only the nest failure, but potentially the cause of nest depredation. Nest success was determined via two methods; 1)data collected in 2010 and 2011 was estimated for each habitat type (objectives 1 and 2) using Dinsmore's model in program MARK to estimate nest success and Mayfield nest density estimates to estimate nest density (Johnson and Shaffer 1990, Dinsmore et al. 2002, McPherson et al, 2003), 2) for Mayfield nest success estimates between 2012 and 2013, nest data cards were analyzed U.S Geological Survey - Northern Prairie Wildlife Research Center in Jamestown, North Dakota.

Field Vegetation, Species Composition and Physiognomy

Throughout the study, vegetation data was collected at each nest discovered as well as randomly within each field. Vegetation data was collected during two distinct phases of growth, during the early nesting season (May 1 – June 10) and again from June 11 – July 15. The purpose was determine the value or structural characteristics of early season residual cover and compare to later season new growth. One random point was created for every 5 acre in a field. At each random point and each nest site, we collected visual obstruction data using the method of Robel et al. (1970) to determine nest structure or visual obstruction used by nesting hens and recorded in decimeters. Random sites were likewise measured to detect patterns if they existed. Vegetation height was assessed visually with the same Robel pole and was averaged from simple visual estimations where at least 3 or more of the tallest stems could be used to determine a maximum vegetation height and likewise recorded in decimeters. Lastly, litter depth was measured randomly in each field and at each nest using a ruler and measured in centimeters. We used the belt transect method as describe by Grant et al. (2004) to obtain species composition or groups of species for each field studied.

Results

Nest Densities

Waterfowl nest densities were similar in both Native and DNC fields, but a slight advantage between the two cover types would hedge towards DNC. Table 1 represents four years of waterfowl nest density data collected at study sites across northeastern North Dakota.

Table 1. Nest densities of prairie nesting ducks within two habitat types, diverse native habitat restoration sites versus non-native dense nesting cover during the 2010 – 2013 breeding seasons within the Devils Lake Wetland Management District.

Field Type (nests)	**Acres Searched**	**Nests/Acre**	**Field Type (nests)**	**Acres Searched**	**Nests/Acre**
2010 Native (n=798)	445	1.793	2010 DNC (n=1,191)	790	1.508
2011 Native (n=515)	445	1.157	2011 DNC (n=1,020)	790	1.291
2012 Native (n=75)	88	0.852	2012 DNC (n=302)	237	1.274
2013 Native (n=114)	159	0.717	2013 DNC (n=271)	173	1.566
TOTALS	**1137**	**1.130 (±.479)**	**TOTALS**	**1990**	**1.410 (±.129)**

Species specific nest densities varied across sites, nesting puddle ducks including mallard, northern pintail, blue-winged teal, northern shoveler and gadwall were of primary focus. Other puddle duck nests that were detected included American wigeon and green-winged teal, but their numbers were too small for any meaningful analysis. We did detect several lesser scaup nests during the study and will create a separate table represent lesser scaup densities and nest success for that species. Table 2 represents nest densities of 5 commonly detected puddle duck species and their distribution within each studied habitat type.

Table 2. Nest densities of 5 species prairie nesting puddle ducks occurring within two habitat types, diverse native habitat restoration sites versus non-native dense nesting cover sites during the 2010 – 2013 breeding seasons within the Devils Lake Wetland Management District.

Species	**Multi-species Native Cover Nests/Acre (±)**	**Dense Nesting Cover Nests/ Acre**
Mallard	**.197 (±.06) (n=237)**	**.323 (± .14) (n=506)**
Northern pintail	**.130 (± .02) (n=140)**	**.134 (±.06) (n=239)**
Blue-winged teal	**.282 (± .14) (n=410)**	**.277 (± .10) (n=665)**
Northern shoveler	**.168 (± .09) (n=232)**	**.177 (± .07) (n=404)**
Gadwall	**.302 (± .16) (n=421)**	**.432 (± .10) (n=836)**

Nest densities for 5 species of prairie nesting puddle ducks showed that they did not nest evenly across both habitat types examined (.10 >P> .25). A simple arithmetic model (Species = Nest/Acre NATIVE x 100, Nest/Acre DNC x 100) examining 320 and 640 acres of prime nesting habitat of either type would predict numbers of nests a manager could expect given optimal breeding conditions (Table 3.).

Table 3. A simple arithmetic model simulating the expected gains in duck nests by restoring incrementally larger blocks of either multi-species native cover or dense nesting cover in landscapes with optimal precipitation and wetland densities within the Devils Lake Wetland Management District, North Dakota.

Speices	Nest/Acre NATIVE	x 100 acre	x 320 acre	x 640 acre
Mallard	**0.197**	**19.7**	**63.04**	**126.08**
Northern Pintail	**0.13**	**13**	**41.6**	**83.2**
Blue-winged teal	**0.282**	**28.2**	**90.24**	**180.48**
Northern Shoveler	**0.168**	**16.8**	**53.76**	**107.52**
Gadwall	**0.302**	**30.2**	**96.64**	**193.28**
Species	**Nest/Acre DNC**	**x 100 acre**	**x 320 acre**	**x 640 acre**
Mallard	**0.323**	**32.3**	**103.36**	**206.72**
Northern Pintail	**0.134**	**13.4**	**42.88**	**85.76**
Blue-winged teal	**0.277**	**27.7**	**88.64**	**177.28**
Northern Shoveler	**0.177**	**17.7**	**56.64**	**113.28**
Gadwall	**0.432**	**43.2**	**138.24**	**276.48**

Overall, waterfowl nests initiated by nesting ducks are presented by species and by habitat type for the reviewer's information in Table 4.

Table 4. Nests by habitat type, year, and waterfowl species detected during 4 years of investigations at select locations within the Devils Lake Wetland Management District, North Dakota.

Nests by Species									
Year	**Mallard**	**Pintail**	**Blue-winged teal**	**Northern shoveler**	**Gadwall**	**Green-winged teal**	**American wigeon**	**Lesser Scaup**	**Yearly Total**
2010 Native	98	61	212	138	254	7	7	21	**798**
2010 DNC	126	96	315	234	346	5	4	65	**1191**
2011 Native	102	43	162	66	125	5	4	8	**515**
2011 DNC	191	85	274	115	317	0	2	36	**1020**
2012 Native	21	12	12	7	18	0	0	5	**75**
2012 DNC	128	18	48	32	71	0	0	5	**302**
2013 Native	16	24	24	21	24	0	0	3	**112**
2013 DNC	61	40	28	23	102	0	4	15	**273**
Totals	**743**	**379**	**1075**	**636**	**1257**	**17**	**21**	**158**	**4286**

Lesser Scaup

Lesser scaup, an upland nesting diving duck and the 6th most abundant species encountered during the study was regularly detected throughout all 4 nesting seasons and a total of 158 nests were detected. Scaup are a waterfowl species which exhibits very strong site fidelity, and of particular interest due to the fact that recent population indices have shown scaup populations in decline and therefore this species is of some elevated importance. Table 5 portraits both scaup nest densities within targeted habitats, and also includes nest success for scaup where analysis was conducted. Numbers of nests are fairly low so results may have high standard deviations from the nest success results, and it is not advisable to assume one habitat type is better than another for scaup.

Table 5. Lesser scaup nest densities and nest success at study locations of both native and non-native vegetation occurring 2010 – 2013 within the Devils Lake Wetland Management District, North Dakota.

Lesser Scaup Nests and Nest Success				
Survey year	Multi-species Native Habitat - Nests (Nest Density/Acre)	Native Habitat Nest Success	Dense Nesting Cover - Nests (Nest Density/Acre)	Dense Nesting Cover Nest Success
2010	21 (.04)	Unknown	65 (.08)	Unknown
2011	8 (.01)	Unknown	36 (.05)	Unknown
2012	5 (.05)	100%	5 (.02)	74%
2013	4 (.02)	21.70%	15 (.08)	21.40%

Nest Success and Nest Phenology

Nest success was rigorously monitored at all study sites over the four years of the study. Some 4,286 duck nests were deemed usable, and Mayfield estimates were generated for each nest from 2010 thru the 2013 nesting season. Likewise, comparisons were made at each study location to detect any patterns or advantages to ducks selecting either Native or DNC vegetation for nesting. Table 6 shows the overall nest success of nesting waterfowl within native and DNC field from 2010 – 2013 breeding season.

Table 6. Nest success by species and habitat type for all usable nests located from 2010 – 2013 waterfowl breeding season within the Devils Lake Wetland Management District, North Dakota.

Study Year	**Nests in Restored Native Cover**	**Mayfield Results in Native Cover**	**Nests in Dense Nesting Cover**	**Mayfield Results in Dense Nesting Cover**	**Seasonal Nest Summary**
2010	**798**	**48.00%**	**1191**	**42.00%**	**1989**
2011	**515**	**13.00%**	**1020**	**37.00%**	**1535**
2012	**75**	**56.00%**	**302**	**55.00%**	**377**
2013	**114**	**35.00%**	**271**	**58.00%**	**385**
Totals	**1,502**	**μ = 38% $\pm$ 18.7**	**2,784**	**μ = 48% $\pm$ 10.1**	**4,286**

Nest success results were well above long term average at all study areas during the study. Typically results for nest success have been historically below 20% in northeastern North Dakota from the 1970's - 2000, so this simple fact is really quite a unique phenomenon within this region of the state. Nest success results were similar for other waterfowl studies within the District between 2010 -2013 as well as conducted by Delta Waterfowl (Mike Buxton pers. comm).

Results from the 2011 field season however were most intriguing due to the low nest success discovered within Native stands during that season. Nest success results for that year were only 13%. Late season success during 2011 within Native stands was dismal (R. Haffele pers. Comm.). However, all other field seasons failed to show this pattern, and 2010, 2012, and 2013 nest success remained consistent from the first, second and third period of the nesting season in all habitat types.

Nest Phenology and Success

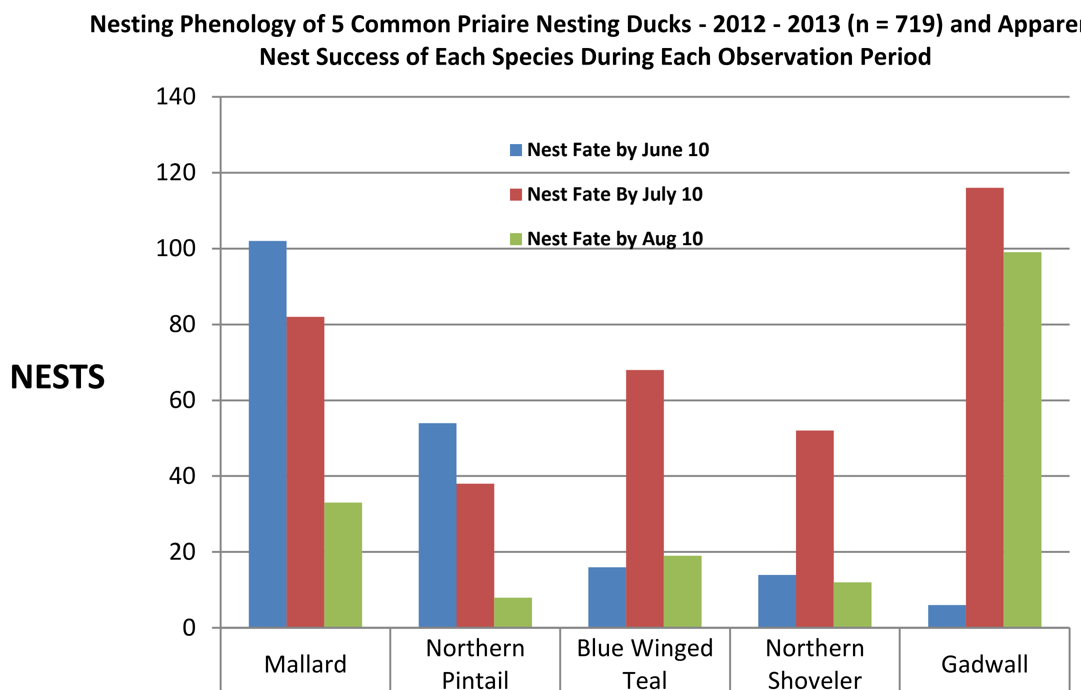
Of particular interest was nest success phenology; was waterfowl nest success equivalent during three periods? We looked at this question for the 2013 field season only, and a quick assessment of nest success and hatching or failure dates were analyzed with <u>apparent nest success</u> as the metric. Time constraints prohibited using the standard Mayfield method to calculate nest success during these time phases, however we could compare the three measurable time periods against the overall Mayfield nest success conducted for each study field. We rated the first period of the season from April 25 thru 20 June, the second time phase from 21 June through 10 July, and the final phase from 11 July through 10 August. Table 7 shows the overall nest success of each study field during three specific time phases for the 2013 field season only.

Table 7. Waterfowl nest phenology and apparent nest success during three distinct time phases during the 2013 breeding season. Also, a comparison of overall nest success at all study fields, and a comparison with the mean Mayfield nest success estimates during the 2013 field season.

Waterfowl Nest Phenology - <u>Apparent</u> Nest Success - 2013 (n=successful nests/total nests)						
Study Field	**Acreage Investigated**	**April 25 - June 10**	**June 11 - July 10**	**July 11 - August 20**	**Combined Season <u>Apparent</u> Success**	**<u>Mayfield Nest Success</u> Estimate, Combined Season (upper and lower hatch rates)**
Lake Alice NWR (DNC)	45	63% (n=15/24)	83% (n=77/93)	63% (n=46/73)	72% (n=138/190)	60% (52% - 70%)
Field 128 (DNC)	128	43% (N=10/23)	81% (N=39/48)	50% (N=10/20)	65% (n=59/90)	57% (46% - 72%)
Field 38 (Native)	38	0% (n=0/4)	50% (n=1/2)	75% (n=3/4)	40% (n=4/10)	15% (3% - 61%)
Field 101 (Native)	101	59% (n=20/34)	73% (n=27/37)	62% (n=13/21)	65% (n=60/92)	43% (33% - 58%)
Lake Alice NWR (Native)	20	0% (n=0/1)	67% (n=2/3)	88% (n= 7/8)	75% (n=9/12)	47% (24% - 91%)

Nest success of individual species and at which time they began or peaked during the nesting periods was also recorded. Table 8 provides a wrap up of all species recorded during the 2013 field season and the periods with which their nesting efforts began, peaked and ended.   This figure is useful for managers that choose to manage habitats, and avoid conflicts with nesting ducks which could still be actively incubating eggs after the August 1 date which is used as a standard date to begin habitat manipulations on Federal lands.

Figure 4. Nesting phenology of 5 common waterfowl species and their nest fate periods detected during the 2012 and 2013 field seasons within the Devils Lake Wetland Management District, North Dakota.



	Mallard	Northern Pintail	Blue Winged Teal	Northern Shoveler	Gadwall
Nest Fate by June 10	102	54	16	14	6
Nest Fate By July 10	82	38	68	52	116
Nest Fate by Aug 10	33	8	19	12	99

Habitat Evaluations

Random habitat evaluations and measurements of actual nest structure were repeatedly collected over 4 years of the study. Vegetation height was collected in 2010 and 2011, and was not collected in 2012 and 2013 due to time constrains. Both random and nest site visual obstruction data, and litter depth was collected during all 4 years of the study. Haffele's 2010 and 2011 data was wisely modeled using Akaike's Information Criterion (AIC) where many distinct habitat parameters were analyzed to determine which set of parameters offered habitat characteristics managers should strive to create if ideal waterfowl nesting habitat were their objectives. These AIC models also attempt to explain which habitat characteristics may explain variation in nest success. Table 8 includes the results of the AIC model run with data from 2010 and 2011 nests used for the results.

Table 8. Model selection results, including number of parameters (K) and model weight(w_i), used to examine factors affecting nest success in multi-species native plantings and dense nesting cover in 2010-2011 in the Devils Lake Wetland Management District, North Dakota.

Model	AICc	ΔAICc	w_i	K	Deviance
Type*Year, Obs[a], Obs[2b], Ht[C], Ht[2d], Litter[e], Den[f]	6,702.51	0.80	0.71	10	6,682.51
Type*Year, Age[g], Obs, Obs^2, Ht, Ht^2, Litter, Den	6,704.46	1.94	0.27	11	6,682.45
Type*Year, Age, Ht, Ht^2, Litter, Den	6,711.47	8.96	0.01	9	6,693.47
Type*Year, Age, Obs, Ht, Ht^2, Litter, Den	6,713.36	10.85	0.01	10	6,693.36
Type*Year, Obs, Ht, Ht^2, Litter, Area[h], Den,	6,714.15	11.64	0.00	11	6,692.14
Type*Year, Age, Obs, Ht, Litter, Area, Den	6,714.45	11.94	0.00	10	6,694.45
Type*Year, Age, Obs, Ht, Ht^2, Den	6,715.05	12.53	0.00	9	6,697.04
Type*Year, Age, Obs, Ht, Ht^2, Litter, Den, Den[2i]	6,715.06	12.55	0.00	11	6,693.06
Type*Year, Age, Obs, Ht, Ht^2, Lit, Lit^2, Den, Den^2	6,716.40	13.89	0.00	12	6,692.40
Type*Year, Age, Obs, Litter, Area, Den	6,724.52	22.01	0.00	9	6,706.52
Type*Year, Age, Obs, Ht, Ht^2, Litter, Area	6,738.99	36.48	0.00	10	6,718.98
Type*Year	6,770.60	68.09	0.00	4	6,762.60
Type + Year	6,823.90	121.38	0.00	3	6,817.90
Year	6,855.96	153.45	0.00	2	6,851.96
Type	6,902.30	199.79	0.00	2	6,898.30
Null	6,917.01	214.49	0.00	1	6,915.01

[a]Cover density around nest
[b]Quadratic term for cover density around nest
[c]Height of vegetation around nest
[d]Quadratic term for height of vegetation
[e]Depth of litter at nest site
[f]Density of nest in the field
[g]Age of nest when found
[h]Area of undisturbed grassland connected to field
[i]Quadratic term for density of nests in field

AIC results indicate that cover density at the nest (visual obstruction), vegetation height, the quadratic term for vegetation height, litter depth, and size of grassland patch and density of nests in the field explained the most variation in nest success. Therefore, managers should strive to have objectives geared toward the improvement of these parameters to maximize productivity at waterfowl breeding sites.

Individual species nest success was also modeled in a similar fashion. Tables 9, 10, 11,12 and 13 were taken from Haffele's M.S. Thesis as explanations of nest success variation within either Native or DNC vegetation for 5 species of upland nesting waterfowl.

Table 9. Model selection results, including number of parameters (K) and model weight (w_i), used to examine factors affecting nest success of northern pintails in 2010-2011 in the Devils Lake Wetland Management District, North Dakota.

Model	AICc	ΔAICc	w_i	K	Deviance
Obs[a], Ht[C], Ht^{2}[d]	451.42	0.00	0.40	4	443.41
Age[g], Obs, Ht, Ht^2	452.22	0.79	0.27	5	442.19
Age, Obs, Obs^{2}[b], Ht, Ht^2	454.14	2.72	0.10	6	442.11
Age, Ht, Ht^2	454.73	3.31	0.08	4	446.72
Age, Obs, Obs^2, Ht,	455.17	3.74	0.06	5	445.15
Age, Obs, Obs^2, Ht, Ht^2, Litter[e]	455.94	4.51	0.04	7	441.90
Age, Obs, Obs^2, Ht, Ht^2, Litter, Area[h]	457.85	6.42	0.02	8	441.80
Age, Obs, Obs^2, Ht, Ht^2, Litter, Area, Den[f]	458.15	6.72	0.01	9	440.08
Null	458.29	6.86	0.01	1	456.29
Age, Obs, Obs^2	458.66	7.23	0.01	4	450.64
Age, Obs, Obs^2, Ht, Ht^2, Litter, Area, Den, Den^{2}[i]	460.12	8.70	0.01	10	440.05

[a]Cover density around nest
[b]Quadratic term for cover density around nest
[c]Height of vegetation around nest
[d]Quadratic term for height of vegetation
[e]Depth of litter at nest site
[f]Density of nest in the field
[g]Age of nest when found
[h]Area of undisturbed grassland connected to field
[i]Quadratic term for density of nests in field

Table 10. Model selection results, including number of parameters (K) and model weight (w_i), used to examine factors affecting nest success of northern shoveler in 2010-2011 in the Devils Lake Wetland Management District, North Dakota.

Model	AICc	ΔAICc	w_i	K	Deviance
Litter[e], Den[f]	1,046.58	0.00	0.57	3	1,040.57
Age[g], Litter, Den	1,048.55	1.97	0.21	4	1,040.54
Age, Obs[a], Litter, Den	1,050.43	3.85	0.08	5	1,040.42
Age, Obs, Obs^2[b], Litter, Den	1,051.64	5.07	0.05	6	1,039.63
Age, Obs, Obs^2, Ht[c], Litter, Den	1,052.05	5.48	0.04	7	1,038.04
Age, Obs, Obs^2, Ht, Ht^2[d], Litter, Den	1,053.03	6.46	0.02	8	1,037.02
Age, Obs, Obs^2, Ht, Ht^2, Den	1,054.14	7.6	0.01	7	1,040.12
Age, Obs, Obs^2, Ht, Ht^2, Litter, Area[h], Den	1,054.98	8.40	0.01	9	1,036.96
Age, Obs, Obs^2, Ht, Ht^2, Litter, Area[h], Den, Den^2[i]	1,055.85	9.28	0.01	10	1,035.83
Null	1,064.55	17.98	0.00	1	1,062.55
Age, Obs, Obs^2, Ht, Ht^2, Litter, Area	1,066.81	20.23	0.00	8	1,050.79

[a]Cover density around nest
[b]Quadratic term for cover density around nest
[c]Height of vegetation around nest
[d]Quadratic term for height of vegetation
[e]Depth of litter at nest site
[f]Density of nest in the field
[g]Age of nest when found
[h]Area of undisturbed grassland connected to field
[i]Quadratic term for density of nests in field

Table 11. Model selection results, including number of parameters (K) and model weight(w_i), used to examine factors affecting nest success of blue-winged teal in 2010-2011 in the Devils Lake Wetland Management District, North Dakota.

Model	AICc	ΔAICc	w_i	K	Deviance
Obs[a], Litter[e], Area[h], Den[f], Den[2i]	1,989.41	0.00	0.50	6	1,977.40
Age, Obs, Litter, Area, Den, Den^2	1,991.41	2.00	0.18	7	1,977.40
Age, Litter, Area, Den, Den^2	1,991.47	2.07	0.18	6	1,979.47
Age, Obs, Obs[2a], Litter, Area, Den, Den^2	1,992.81	3.40	0.09	8	1,976.80
Age, Obs, Obs^2, Ht[c], Litter, Area, Den, Den^2	1,994.72	5.31	0.04	9	1,976.70
Age, Obs, Obs^2, Ht, Ht[2d], Litter, Area, Den, Den^2	1,996.71	7.30	0.13	10	1,976.69
Age, Obs, Obs^2, Ht, Ht^2, Litter, Den, Den^2	2,001.79	12.39	0.00	9	1,983.78
Age, Obs, Obs^2, Ht, Ht^2, Litter, Area, Den	2,004.82	15.41	0.00	9	1,986.80
Age, Obs, Obs^2, Ht, Ht^2, Litter, Area,	2,007.38	17.98	0.00	8	1,991.37
Age, Obs, Obs^2, Ht, Ht^2, Area, Den, Den^2	2,007.55	18.15	0.00	9	1,989.54
Null	2,015.79	26.39	0.00	1	2,013.79

[a]Cover density around nest
[b]Quadratic term for cover density around nest
[c]Height of vegetation around nest
[d]Quadratic term for height of vegetation
[e]Depth of litter at nest site
[f]Density of nest in the field
[g]Age of nest when found
[h]Area of undisturbed grassland connected to field
[i]Quadratic term for density of nests in field

Table 12. Model selection results, including number of parameters (K) and model weight(w_i), used to examine factors affecting nest success of gadwall in 2010-2011 in the Devils Lake Wetland Management District, North Dakota.

Model	AICc	ΔAICc	w_i	K	Deviance
Ht[c], Ht[2d] Den[f], Den[2i]	1,897.61	0.00	0.38	5	1,887.60
Age[g], Ht, Ht^2, Den, Den^2	1,898.4	0.83	0.25	6	1,886.43
Age, Obs[a], Ht, Ht^2 Den, Den^2	1,899.46	1.85	0.15	7	1,885.45
Age, Obs, Obs[2b], Ht, Ht^2 Den, Den^2	1,900.88	3.27	0.07	8	1,884.87
Age, Obs, Obs^2, Ht, Den, Den^2	1,901.30	3.69	0.06	7	1,887.29
Age, Obs, Obs^2, Ht, Litter[e], Den, Den^2	1,901.71	4.10	0.05	9	1,883.69
Age, Obs, Obs^2, Ht, Ht^2, Litter, Area[h], Den, Den^2	1,902.91	5.30	0.00	10	1,882.89
Age, Obs, Obs^2, Ht, Ht^2, Litter, Area	1,904.60	6.99	0.00	7	1,890.59
Age, Obs, Obs^2, Ht, Ht^2, Litter, Area, Den	1,907.94	10.34	0.00	9	1,889.93
Null	1,913.28	15.67	0.00	1	1,911.28
Age, Obs, Obs^2, Den, Den^2	3,278.94	,381.34	0.00	5	3,268.94

[a]Cover density around nest
[b]Quadratic term for cover density around nest
[c]Height of vegetation around nest
[d]Quadratic term for height of vegetation
[e]Depth of litter at nest site
[f]Density of nest in the field
[g]Age of nest when found
[h]Area of undisturbed grassland connected to field
[i]Quadratic term for density of nests in field

Table 13. Model selection results, including number of parameters (K) and model weight(wi), used to examine factors affecting nest success of mallard in 2010-2011 in the Devils Lake Wetland Management District, North Dakota.

Model	AICc	ΔAICc	w_i	K	Deviance
Ht[c], Ht[2d] Den[f], Den[2i]	1,120.89	0.00	0.42	5	1,110.88
Age[g], Ht, Ht^2, Den, Den^2	1,121.46	0.56	0.31	6	1,109.44
Age, Obs[a], Ht, Ht^2 Den, Den^2	1,123.06	2.17	0.14	7	1,109.04
Age, Obs, Obs[2b], Ht, Ht^2 Den, Den^2	1,124.99	4.10	0.05	8	1,108.97
Age, Obs, Obs^2, Den, Den^2	1,126.86	5.97	0.02	6	1,114.85
Age, Obs, Obs^2, Ht, Ht^2, Litter[e], Den, Den^2	1,126.90	6.01	0.00	9	1,108.87
Age, Obs, Obs^2, Ht, Den, Den^2	1,127.15	6.26	0.00	7	1,113.13
Age, Obs, Obs^2, Ht, Ht^2, Litter, Area[h], Den, Den^2	1,128.80	7.91	0.00	10	1,108.77
Age, Obs, Obs^2, Ht, Ht^2, Litter, Area, Den	1,129.77	8.87	0.00	9	1,111.74
Age, Obs, Obs^2, Ht, Ht^2, Litter, Area	1,131.45	10.55	0.00	8	1,115.42
Null	1,140.26	19.37	0.00	1	1,138.26

[a]Cover density around nest
[b]Quadratic term for cover density around nest
[c]Height of vegetation around nest
[d]Quadratic term for height of vegetation
[e]Depth of litter at nest site
[f]Density of nest in the field
[g]Age of nest when found
[h]Area of undisturbed grassland connected to field
[i]Quadratic term for density of nests in field

During the 2012 and 2013 field seasons, nest sites were monitored along with random locations to discern patterns of habitat use by nesting ducks. This is very important data and will be beneficial to managers who need objective driven management strategies when burning, grazing or haying grasslands. Table 14 illustrates differences in Native stands and compares directly with DNC. As Haffle also concurred in his M.S. thesis, waterfowl selected habitat characteristics slightly less robust than habitat at random locations. In any event, these are “real world” objectives land managers can use to achieve ideal waterfowl habitat structure, or at least work towards that objective with upland habitat management prescriptions.

Table 14. Visual obstruction and litter depth data collected from waterfowl nests and from random locations at each study site during the 2012 – 2013 field seasons within the Devils Lake Wetland Management District, North Dakota.

2012-2013 Habitat Measurements	Random	Nests	Random	Nests	Random	Nests	Random	Nests	Random	Nests
	North (dm)		East (dm)		South (dm)		West (dm)		Litter (cm)	
Fld 38 (Native)	3.06	3.05	3.25	2.80	3.00	2.60	3.17	2.40	1.66	3.94
Fld 101 (Native)	3.73	2.68	3.28	2.47	3.40	2.30	3.43	2.34	5.24	4.21
LANWR (Native)	2.85	2.59	2.35	2.64	2.81	2.36	2.77	2.91	4.51	4.68
Native Averages	**3.21**	**2.77**	**2.96**	**2.64**	**3.07**	**2.42**	**3.12**	**2.55**	**3.80**	**4.28**
LANWR (DNC)	4.42	4.48	4.12	4.48	3.96	4.46	4.27	4.53	5.03	4.91
Fld 128 (DNC)	3.44	2.72	3.05	2.79	3.05	2.75	3.31	2.76	3.17	3.61
2012 DNC	3.82	3.46	4.04	3.24	3.86	3.03	3.96	3.35	4.59	3.66
DNC Averages	**3.89**	**3.55**	**3.74**	**3.50**	**3.62**	**3.41**	**3.85**	**3.55**	**4.26**	**4.06**

It is interesting to note that difference in visual obstruction between Native and DNC stands is consistently lower for Natives at all 4 cardinal locations compared with DNC. This suggests less robustness within Native stands, but also explains greater habitat heterogeneity in Native stands, which may be a habitat characteristic potentially supporting a greater diversity of wildlife. In any event, northern pintails, northern shoveler and blue-winged teal were found about equally in all cover types, while mallard and gadwall were found in greater abundance in DNC which concurred completely with Tables 9 – 13.

Discussion

I have decided to forego a litany of scientific citations for this part of the report. I would suggest for an excellent discussion regarding waterfowl nesting within either restored grassland type, please read Ryan Haffele's M.S Thesis. I will attempt to give an account of what it is really like to restore landscapes with either DNC or multi-species Native mixtures, this is what I do as a landscape restorationist and biologist. This section is simply a "conversation" from the author who has restored a few thousand acres of upland habitat to the reader.

Dense Nesting Cover (<u>Advantages</u>)

There are advantages to using the DNC mixtures, despite some documentation to the contrary as described by Haffele. Haffele describes the intensity of management of DNC which is simply untrue; DNC is the easiest mixture to physically plant, establish, and manage. Typically managers will elect to burn or hay a DNC stand about 1 – 2 times during its life cycle (normally 12 – 15 years) to retain its waterfowl nesting productivity. Another great advantage of DNC is that it performs well on soils that are laden with calcium carbonate or on saline soils where most other plants simply will not grow. A restoration project must strongly consider these abiotic factors to achieve success; it may be a waste of precious financial resources to plant many species of native vegetation that simply will not grow on marginal soils. There is no doubt that DNC is premium waterfowl nest cover as described by results gleaned in this study, and has been published by numerous waterfowl biologists; waterfowl nests in Table 2 show the significantly higher nest densities of both mallard and gadwall in DNC. DNC is very robust cover which likely favors the mallard and gadwall for nesting, and this robustness may be advantageous with regards to improved waterfowl nesting success. Other unpublished fieldwork has shown that DNC will attract nesting and foraging habitat for some grassland songbirds (bobolink (*Dolichonyx oryzivorus*) are commonly observed in DNC), and DNC will also act as a surrogate habitat for numerous pollinators. DNC is relatively cheap, seed price can vary from $20 - $40 (todays price) per acre. DNC seed is easy to acquire and plant, and can be broadcast or planted in a grass drill. Because of the species present, DNC can be planted during a fall dormant window (post Oct 20) and in early spring by May 20. DNC is planted at roughly 10-11 lbs pure live seed/acre, this makes it very easy to calibrate in a grass drill and physically plant. One must appreciate the work of the waterfowl pioneers such as Harold Duebbert, John Lokemoen, Arnold Kruse, Lewis Cowardin, Hal Kantrud and others, who saw a need to replace black dirt with upland nesting cover, and developed this mixture that could be easily established by landowners and land managers across the Prairie Pothole Region while simultaneously "saving the dirt" and "growing ducks"!

Dense Nesting Cover (<u>Disadvantages</u>)

Dense nesting cover is not diverse, it contains 4 species of non-native plants; tall wheatgrass (45%), intermediate wheatgrass (25%), alfalfa (20%), yellow sweetclover (10%). Yellow sweetclover has become a significant escaped invasive species invading native rangeland so planting this species has become problematic and not compatible for managers of native prairie habitats. If DNC is planted today, most managers elect to eliminate sweetclover from the DNC mixtures. DNC is a short lived "semi-permanent" cover that is not intended to persist on the prairie landscape beyond 12-15 years. DNC is not considered resilient or resistant to weed invasions or invasive species. The overall carbon footprint required to manage and implement DNC would likely be higher than in a longer term Native stand. DNC species are shallower rooted plants and therefore are not considered drought tolerant leading to a lack of resilience in the face of weather oscillations. DNC is more of a mono-typical stand of 2 non-native cool season grasses and 2 forbs, it is more homogenous with regard to habitat structure and theoretically this could limit its overall wildlife value. DNC does not occupy or saturate many niches on the landscape which again leads itself to invasions from numerous other species. Excessive management of DNC will significantly limit its productivity; tall wheatgrass in particular is a short lived bunch grass which can be eliminated from a DNC stand with excessive haying or excessive early season grazing. Due to DNC's poor resistance, DNC is susceptible to smooth brome invasions which have occurred on many thousands of acres across the Dakotas. Also, alfalfa is a favorite plant of pocket gophers (*Thomomys talpoides)* which when gophers are present, the soil disturbance they create provides a microhabitat for noxious weed invasions, especially Canada thistle (*Cirsium arvense*).

Multi-species Native Upland Mixes (Natives) (<u>Advantages</u>)

While Native restoration of tallgrass prairie has been ongoing for over 25 years, the science of restoring a "mixed-grass" landscape using Native mixtures is relatively new. Major advantages of Natives (grass and forb mixtures over 20 species) is the observed species richness 3-8 years post restoration. Data from our oldest Native mixture site (10 years) have continually improved both in species richness and structure, with periodic management. Due to the occupation of numerous niches within a restoration site, it is difficult for invasive species to infiltrate a Native stand, hence suggesting that "resistance" is major defensive aspect of Native restoration success. Normally few noxious weeds and invasive grasses can occur, but to a pre-restoration level acceptable by the restorationist as successful (invasive < 20% of the stand). Due to the deep rooted nature of many of the prairie grasses, these species are well suited to undergo a wide range of climatic oscillations, hence Native stands are very resilient. Resiliency is a critical component of any functional landscape, and it may well be suited that Native stands, moving forward, are certainly a valuable tool land managers should regularly select provided funding is available. Conservation biologists routinely tout the many values of species diversity and habitat connectivity as objectives towards slowing down climate change; Native stands certainly provide those characteristics. The physical structure of Native stands is certainly more heterogeneous, and this may be one of the greatest benefits of Native habitat restorations as they pertain to a whole host of native fauna. While Native habitat did not achieve duck nest densities greater than DNC, there was no question that when looking at ducks as individual species, northern pintail, blue-winged teal and northern shoveler showed no difference in selecting either habitat type. Therefore, Native nest cover offers perhaps a wider range of waterfowl species nest densities, more so than DNC. Perhaps the next wave of research is to investigate total faunal diversity in Native stands. This study showed that ducks will nest in either habitat type, and ancillary benefits of habitat diversity upon the prairie landscape are one of the many additional ecological services provided by this habitat restoration technique.

Multi-species Native Upland Mixes (Natives) (Disadvantages)

Native habitat restoration has few disadvantages, but perhaps the biggest is the uncertainty that this habitat type will remain resilient over time. We have been monitoring our Native restoration sites for only 10 years, a very short temporal period in the real world. Continual monitoring makes Natives stands more labor intensive, and there are certainly costs associated with doing so. Native stands are harder to plant due to the physical structure of some of the fluffy grass seeds. Because of this, seed mixtures are often planted at very low rates – sometimes as low as 7 lbs of pure live seed to the acre. This can be very difficult to calibrate a grass drill and it is critical that during planting, one frequently gets out and looks at the seed/soil contact and that the right rate is being applied. Soils are another limiting factor as most highly diverse mixtures may have limitations on marginal soils, especially soils high in salinity. Native plantings do excellent on high quality soils and there should be no reason not to use them at those sites, but given most lands that are owned by the USFWS, the land was likely sold to the government due to the unproductive nature of the soils. Establishment of Native stands is more labor intensive, although some believe that idling the stand despite the weed pressures within the first 3-5 years will result in a stand of grasses and forbs that will eventually out-compete weeds. Haffele found that duck nest failure may also be higher in Native stands than DNC, but this was only for 1 year as in other years Native stands maintained nest success well above 20%. Seed sources, seed availability and seed costs can vary wildly from year to year. Also, getting the right seed eco-type is also another potential problem as often the seed source is from a location not desirable for use in our ecoregion. These are the hard lessons we have learned over the years, but are reducing the uncertainty and more frequently achieving more success as we continue to learn from past mistakes, truly adaptive management in action.

Conclusion

With help from the State Wildlife Grant Program, we have attempted to answer a question, "Do multi-species Native stands produce an adequate number of waterfowl which is comparable to non-native dense nesting cover"? The answer is yes, and in doing so provides many more ecological services to our prairie landscapes. As we improve our restoration techniques, it is imperative that this information is filtered to private, State and Federal land managers across the Prairie Pothole Region. Certainly northeastern North Dakota is a highly fragmented landscape with monocultures of soybeans, corn and other agricultural commodities defining our current landscape. Our wetland densities are high however, and the amount of true native prairie and planted cover in the landscape low; we are grass poor in this corner of the state. But where opportunities abound, we have every reason to diversify our landscape, and be able to claim that our plant diversity work has positive outcomes for prairie nesting ducks, and is one small step for reducing our carbon footprint and stemming the tide of global climate change.

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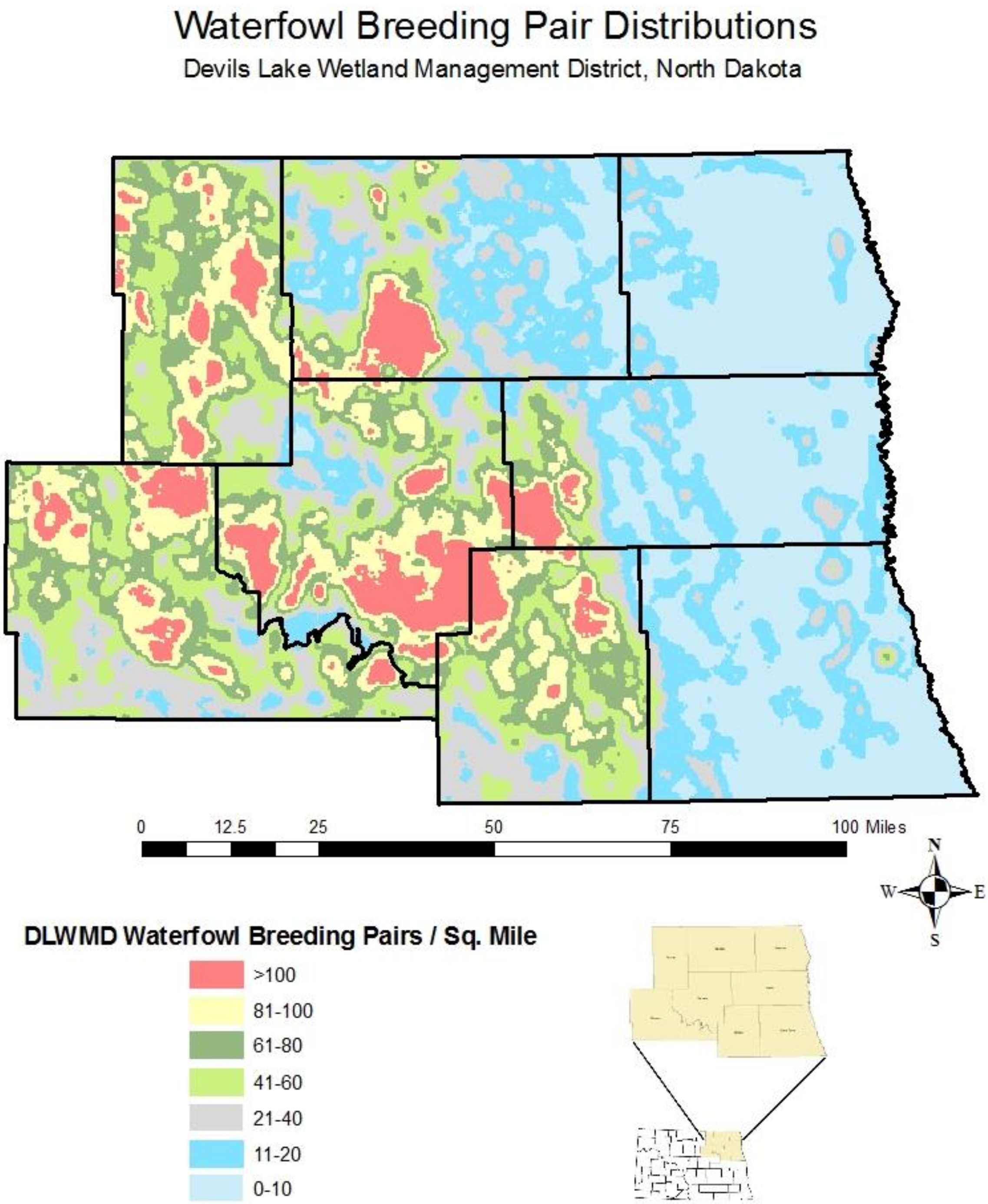


Figure 1. Devils Lake Wetland Management District Waterfowl Pair Densities.

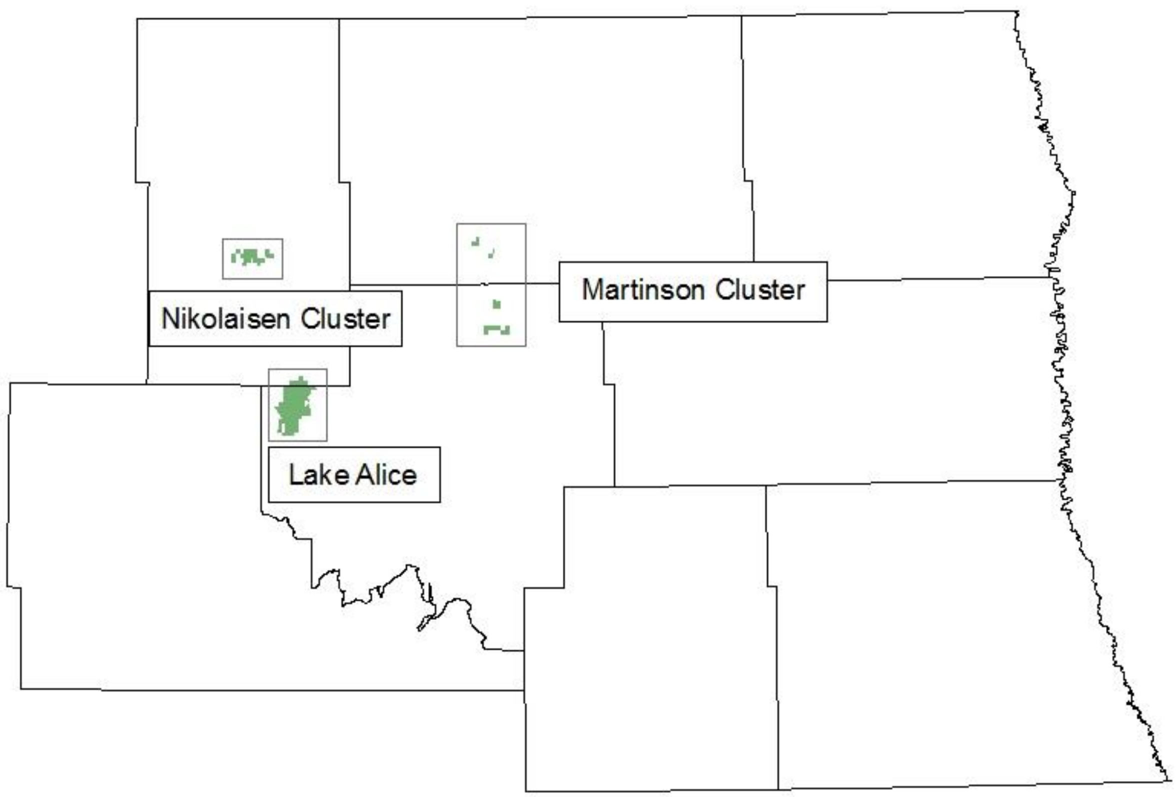


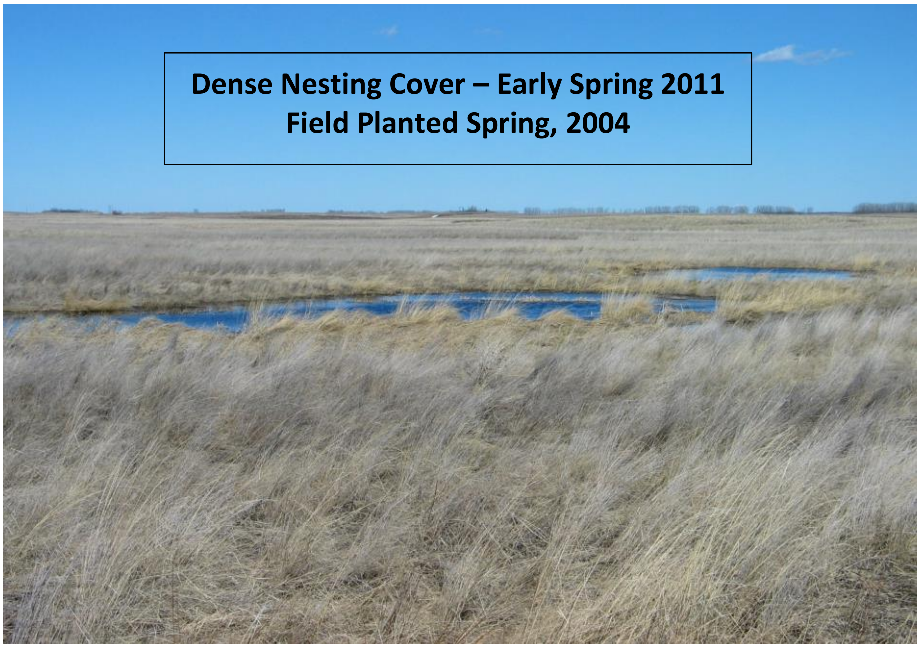
Figure 2. Map of the study sites in the Devils Lake Wetland Management District, ND.

ACRES TO BE SEEDED: 190

PURE LIVE SEED NEEDS

[1] SPECIES NO.	[2] SPECIES NAME	2 VARIETY	3 Full seeding rate pls.	4 % desired in mix	5 seeded pls. lbs/ac	6 Acres to be seeded	7 Total pls. lbs	8 Cost per pls. lb.	9 **TOTAL COST**
17	BIG BLUESTEM	Bison	7.9	7.0%	0.6	190	105.1	$14.00	$1,471
19	LITTLE BLUESTEM	Itasca	5.0	10.0%	0.5	190	95.0	$20.00	$1,900
20	INDIANGRASS	Tomahawk	7.9	7.0%	0.6	190	105.1	$25.00	$2,627
21	SWITCHGRASS	Dacotah	7.0	5.0%	0.4	190	66.5	$7.50	$499
24	SIDEOATS GRAMA	Killdeer	7.5	5.0%	0.4	190	71.3	$14.00	$998
35	CANADA WILDRYE	Mandan	7.5	5.0%	0.4	190	71.3	$11.00	$784
22	GREEN NEEDLEGRASS	Lodorm	7.1	12.0%	0.9	190	161.9	$7.50	$1,214
28	SLENDER WHEATGRASS	Revenue	6.5	5.0%	0.3	190	61.8	$4.00	$247
26	WESTERN WHEATGRASS	Rodan or Rosana	12.0	10.0%	1.2	190	228.0	$7.00	$1,596
39	PRAIRIE DROPSEED	Goshen	5.0	5.0%	0.3	190	47.5	$75.00	$3,563
25	BLUE GRAMA	Bad River	2.5	6.0%	0.2	190	28.5	$24.00	$684
62	PURPLE PRAIRIECLOVER		3.8	3.0%	0.1	190	21.7	$32.00	$693
63	MAX. SUNFLOWER	Medicine Crk.	1.0	2.0%	0.0	190	3.8	$40.00	$152
65	PRAIRIE CONEFLOWER		1.5	2.0%	0.0	190	5.7	$32.00	$182
47	BLACK-EYED SUSAN		0.8	2.0%	0.0	190	3.0	$25.00	$76
66	PURPLE CONEFLOWER		9.0	2.0%	0.2	190	34.2	$30.00	$1,026
69	LEWIS FLAX		3.8	2.0%	0.1	190	14.4	$25.00	$361
68	WILD BERGAMOT		0.9	2.0%	0.0	190	3.4	$85.00	$291
57	BLANKETFLOWER		7.0	2.0%	0.1	190	26.6	$45.00	$1,197
76	WHITE PRAIRIECLOVER		3.9	1.0%	0.0	190	7.4	$40.00	$296
60	SHELL-LEAF PENSTEMON		4.0	1.0%	0.0	190	7.6	$135.00	$1,026
	STIFF GOLDENROD		10.0	1.0%	0.1	190	19.0	$135.00	$2,565
	GOLDEN ALEXANDER		2.5	1.0%	0.0	190	4.8	$75.00	$356
48	CANADA MILKVETCH		4.0	1.0%	0.0	190	7.6	$45.00	$342
61	LEADPLANT		5.4	1.0%	0.1	190	10.3	$80.00	$821
				100.0%				**TOTAL ESTIMATED GRASS SEED COSTS**	**$24,967**

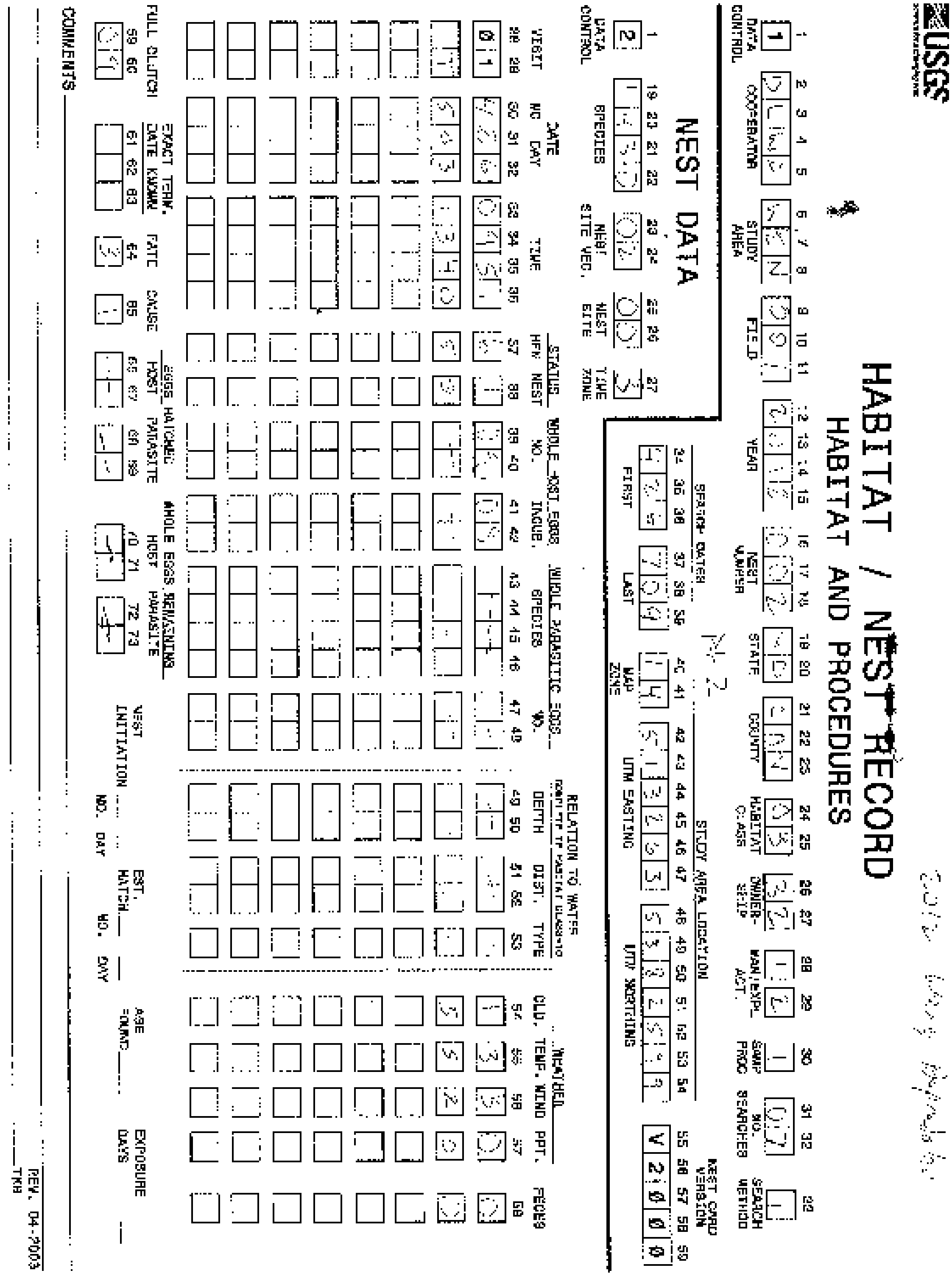
Figure 3. Typical planning sheet used to plan multi-species native plant mixes for upland restoration within the Devils Lake Wetland management district, North Dakota.



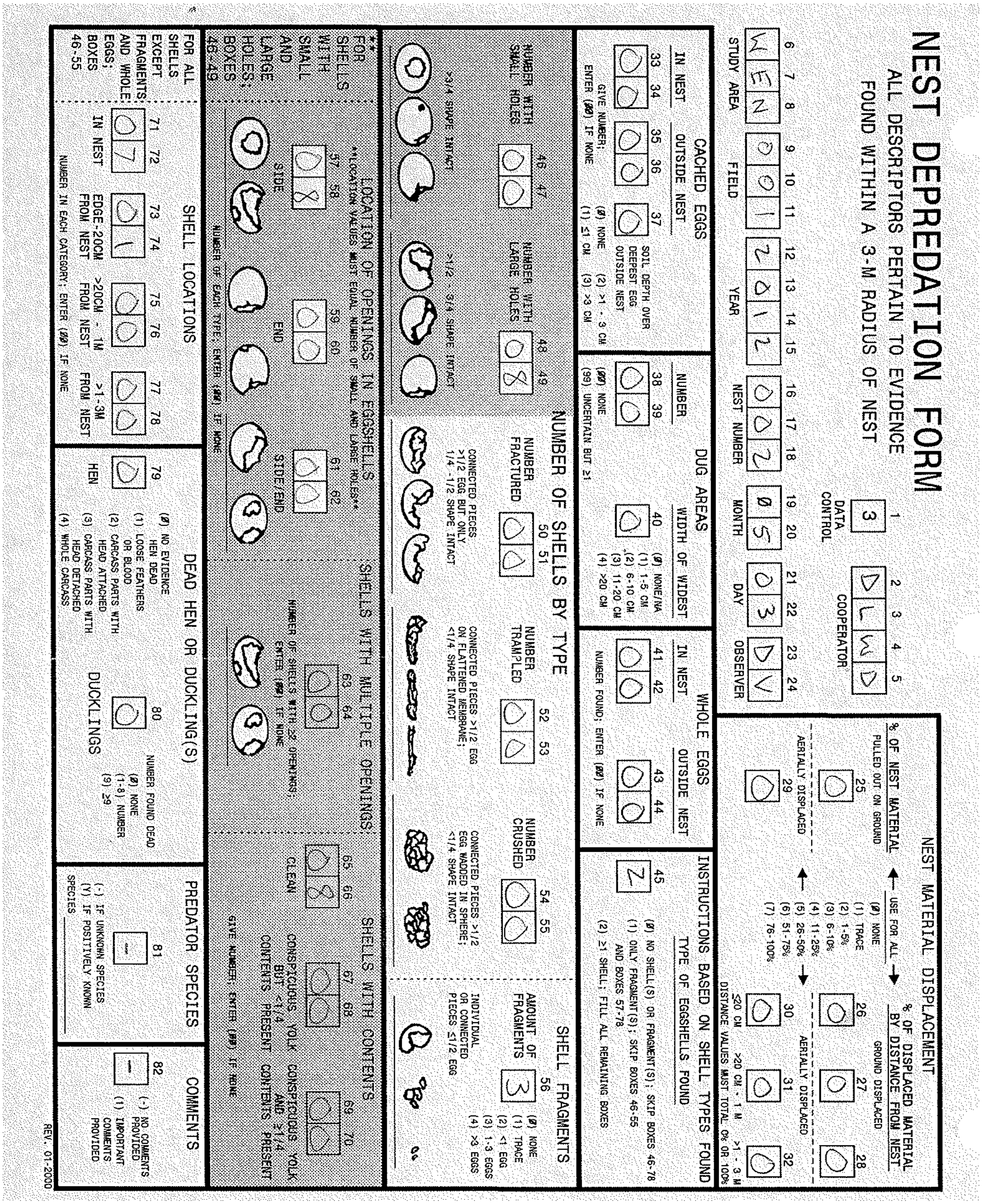
Multi-species Native Mixture, Summer 2011
Field Planted Spring, 2006

Figure 4. Photographs of dense nesting cover and multi-species native mixtures taken within the Devils Lake Wetland Management District, North Dakota.

Appendix 1. Nest cards used to record waterfowl nest data and subsequent site visit information for Mayfield analysis during the 2010 – 2013 waterfowl nest data collection, Devils Lake Wetland Management District, North Dakota.



Appendix 2. Waterfowl Nest Depredation Form for recorded depredated nests for analysis to determine potential nest predators at nest sites during 2010 – 2013 waterfowl nest project, Devils Lake Wetland Management District, North Dakota.



NEST DEPREDATION FORM

ALL DESCRIPTORS PERTAIN TO EVIDENCE FOUND WITHIN A 3-M RADIUS OF NEST

DATA CONTROL 1: 3

COOPERATOR 2 3 4 5: D L W D

STUDY AREA 6 7 8: W E N | FIELD 9 10 11: 0 0 1 | YEAR 12 13 14 15: 2 0 1 2 | NEST NUMBER 16 17 18: 0 0 2 | MONTH 19 20: 0 5 | DAY 21 22: 0 3 | OBSERVER 23 24: D V

NEST MATERIAL DISPLACEMENT

% OF NEST MATERIAL: PULLED OUT ON GROUND 25: 0 | AERIALLY DISPLACED 29: 0

USE FOR ALL: (0) NONE (1) TRACE (2) 1-5% (3) 6-10% (4) 11-25% (5) 26-50% (6) 51-75% (7) 76-100%

% OF DISPLACED MATERIAL BY DISTANCE FROM NEST: GROUND DISPLACED 26 27 28: 0 0 0 | AERIALLY DISPLACED 30 31 32: 0 0 0

≤20 CM | >20 CM - 1 M | >1 - 3 M

DISTANCE VALUES MUST TOTAL 0% OR 100%

CACHED EGGS: IN NEST 33 34: 0 0 | OUTSIDE NEST 35 36: 0 0 | 37 SOIL DEPTH OVER DEEPEST EGG OUTSIDE NEST: 0

GIVE NUMBER; ENTER (00) IF NONE | (0) NONE (1) ≤1 CM (2) >1 - 3 CM (3) >3 CM

DUG AREAS: NUMBER 38 39: 0 0 | (00) NONE (99) UNCERTAIN BUT ≥1 | WIDTH OF WIDEST 40: 0 | (0) NONE/NA (1) 1-5 CM (2) 6-10 CM (3) 11-20 CM (4) >20 CM

WHOLE EGGS: IN NEST 41 42: 0 0 | OUTSIDE NEST 43 44: 0 0 | NUMBER FOUND; ENTER (00) IF NONE

INSTRUCTIONS BASED ON SHELL TYPES FOUND: TYPE OF EGGSHELLS FOUND 45: 2

(0) NO SHELL(S) OR FRAGMENT(S); SKIP BOXES 46-78
(1) ONLY FRAGMENT(S); SKIP BOXES 46-55 AND BOXES 57-78
(2) ≥1 SHELL; FILL ALL REMAINING BOXES

NUMBER OF SHELLS BY TYPE

NUMBER WITH SMALL HOLES 46 47: 0 0 | NUMBER WITH LARGE HOLES 48 49: 0 8

>3/4 SHAPE INTACT | >1/2 - 3/4 SHAPE INTACT

NUMBER FRACTURED 50 51: 0 0 | CONNECTED PIECES >1/2 EGG BUT ONLY 1/4 - 1/2 SHAPE INTACT

NUMBER TRAMPLED 52 53: 0 0 | CONNECTED PIECES >1/2 EGG ON FLATTENED MEMBRANE; <1/4 SHAPE INTACT

NUMBER CRUSHED 54 55: 0 0 | CONNECTED PIECES >1/2 EGG WADDED IN SPHERE; <1/4 SHAPE INTACT

SHELL FRAGMENTS: AMOUNT OF FRAGMENTS 56: 3 | INDIVIDUAL OR CONNECTED PIECES ≤1/2 EGG | (0) NONE (1) TRACE (2) <1 EGG (3) 1-3 EGGS (4) >3 EGGS

** FOR SHELLS WITH SMALL AND LARGE HOLES; BOXES 46-49

LOCATION OF OPENINGS IN EGGSHELLS **LOCATION VALUES MUST EQUAL NUMBER OF SMALL AND LARGE HOLES**

SIDE 57 58: 0 8 | END 59 60: 0 0 | SIDE/END 61 62: 0 0 | NUMBER OF EACH TYPE; ENTER (00) IF NONE

SHELLS WITH MULTIPLE OPENINGS: 63 64: 0 0 | NUMBER OF SHELLS WITH ≥2 OPENINGS; ENTER (00) IF NONE

SHELLS WITH CONTENTS: CLEAN 65 66: 0 8 | CONSPICUOUS YOLK BUT <1/4 CONTENTS PRESENT 67 68: 0 0 | CONSPICUOUS YOLK AND ≥1/4 CONTENTS PRESENT 69 70: 0 0 | GIVE NUMBER; ENTER (00) IF NONE

FOR ALL SHELLS EXCEPT FRAGMENTS AND WHOLE EGGS; BOXES 46-55

SHELL LOCATIONS: IN NEST 71 72: 0 7 | EDGE-20CM FROM NEST 73 74: 0 1 | >20CM - 1M FROM NEST 75 76: 0 0 | >1-3M FROM NEST 77 78: 0 0 | NUMBER IN EACH CATEGORY; ENTER (00) IF NONE

DEAD HEN OR DUCKLING(S): HEN 79: 0 | (0) NO EVIDENCE HEN DEAD (1) LOOSE FEATHERS OR BLOOD (2) CARCASS PARTS WITH HEAD ATTACHED (3) CARCASS PARTS WITH HEAD DETACHED (4) WHOLE CARCASS

DUCKLINGS 80: 0 | NUMBER FOUND DEAD (0) NONE (1-8) NUMBER (9) ≥9

PREDATOR SPECIES 81: - | (-) IF UNKNOWN SPECIES (Y) IF POSITIVELY KNOWN SPECIES

COMMENTS 82: - | (-) NO COMMENTS PROVIDED (1) IMPORTANT COMMENTS PROVIDED

REV. 01-2000